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AUTHOR Greenberg, Redge L.
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ABSTRACT

To better understand the effect of student background, work load, and attitudes on performance in intermediate algebra, a study was conducted in summer 1990 among students at a central Texas community college using pre- and post-course questionnaires completed by 124 of 157 students in 8 sections of intermediate algebra. Respondents were classified as either successful (receiving a course grade of A, B, or C) or unsuccessful (receiving a course grade of D, F, or withdrawing from the course). Variables examined included; mathematics enjoyment, amount of outside help needed to understand course material, and the attribution of failure or difficulty to course structure or quality of instruction. Correlations examined included the extent to which a student's belief in the efficacy of effort predicts effort, and the extent to which the belief that one has high ability and does not have to work hard predicts less effort. Study findings included the following: (1) 92% of successful students and only 56% of unsuccessful students correctly predicted what their course grade would be; (2) 91% of unsuccessful students believed that their achievement was higher than their grades would reflect; (3) for unsuccessful students, a strong correlation was observed between not working hard and the belief that hard work was not necessary because of high ability; and (4) unsuccessful students took a larger course load than successful students. A literature review of the research on behavioral and attitudinal correlates of mathematics achievement, and the study survey instrument are included. (GFW)

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Redge L. Greenberg

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FACTORS AFFECTING ACHIEVEMENT IN ALGEBRA AT A COMMUNITY COLLEGE

by Redge L. Greenberg

ABSTRACT

Intermediate algebra students at a central Texas community college completed questionnaires which dealt with attitudes and other factors that are believed to influence achievement related behavior. Several items on the questionnaires were found to be significant in distinguishing successful from unsuccessful students.

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Research during the past 15 years has related achievement in mathematics to motivation, sex, race, socioeconomic status (SES), and anxiety. These studies have shown that socialization probably affects achievement in important ways.

A rich area of research among educational psychologists is the investigation of achievement related motivation. Early theories of motivation included the behaviorist perspective, in which the learner was viewed as passively responding to environmental stimuli, and the dynamic personality perspective in which motivation was viewed as a general aspect of personality. More recent studies focus on the social-cognitive perspective (Schallert, 1990). In this view, ability interacts with attitude in a cognitive process, resulting in adaptive and maladaptive learning goals.

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Two fundamental goal orientations are recognized, a performance goal in which the learner seeks to demonstrate ability relative to some perceived standard, and a learning or mastery goal, in which the learner seeks to demonstrate ability by improving competence (Dweck and Leggett, 1988). A student with a performance goal tends to attribute failure to a lack of innate ability, and may adopt a pattern known as learned helplessness when faced with difficult tasks. A learned helpless student tends to avoid challenge, and shows a lack of persistence when encountering difficult tasks (Diener and Dweck, 1978). A student exhibiting learned helplessness would likely attribute success to luck and failure to a lack of ability, both attributions to uncontrollable factors. A student with a mastery goal, on the other hand, tends to seek challenge and shows persistence when having difficulty. A mastery oriented student is likely to attribute failure to insufficient effort rather than a lack of innate ability (Elliot and Dweck, 1988).

A student with high ability may function equally well with either goal orientation, but a low ability student, who is likely to experience occasional failure, would be expected to perform much better with a learning goal. These ideas were tested by Elliot and Dweck (1988) in an experiment involving 5th grade students. Both the theories of intelligence and the goal orientations of the students were manipulated by the researchers resulting in the predicted adaptive and maladaptive behavior patterns in the face of failure.

Kloosterman (1988) studied the attributions for success or failure by 7th grade mathematics students, concluding that student attributions were related to self confidence and motivation in a manner consistent with theory. In particular, students who believed that

success was controllable through effort were more likely to adopt a mastery pattern of behavior than were students who believed that success or failure was mostly determined by innate ability, an uncontrollable factor.

Powers, Choroszy, Douglas, and Cool (1986) investigated the attributions and goal orientations of a group of algebra students at a community college in American Samoa, and compared the results to similar measurements made on a group of 9th and 10th grade mainland students. They found that the Samoan students were more likely to attribute success to effort and to a conducive learning environment, and less likely to attribute failure to task difficulty than the mainland students. The Samoan students seemed more likely to adopt a learning goal than mainland students.

Lower than average mathematics achievement has been noted among women (Fennema and Carpenter, 1981), Blacks and Hispanics (Anick and Smith, 1981), and students from low socioeconomic status (SES) groups (Horn and Walburg, 1984). Based on a literature review, Fennema (1974) concluded that female students achieve on par with male students until late in high school at which time male student achievement becomes higher. Female, Black, Hispanic and low SES students tend to take fewer and lower level mathematics courses than average students after early high school, but inadequate course background due to mathematics avoidance appears to account for only a small portion of the achievement disparity (Fennema and Carpenter, 1981, Anick and Smith, 1981).

Environmental factors may adversely affect mathematics achievement of female, Black, Hispanic and low SES students. Fennema and Peterson (1985) proposed that socialization factors contribute to more dependent behavior by females resulting in less persistence in,

and more avoidance of, high level mathematics tasks. Female students may also be more vulnerable to learned helplessness (Wolleat, et al, 1980). Horn and Walburg (1984) reported that the educational level of parents and the quality of the home environment, as indicated by the presence of stimulating objects such as magazines and encyclopedias, correlate significantly with achievement. Students from a low SES background, including a large percentage of Blacks and Hispanics, are likely to be disadvantaged relative to these factors.

Anxiety concerning mathematics might reduce student achievement, either by leading to avoidance of needed courses, or by reducing cognitive performance. Students' attributions for success and failure may affect their levels of anxiety. Powers, et al (1986) found that algebra students at a community college in American Samoa who attributed success to ability were less anxious than students who attributed success to effort. Female students appear to be more vulnerable to mathematics anxiety than male students (Betz, 1978, Hackett, 1985, Liabre and Suarez, 1985), but whether the tendency toward anxiety is innate or the product of socialization is unclear.

Mathematics anxiety seems to correlate negatively with performance in mathematics (Gourgey, 1982, Goolsby, et al, 1987). However, it is unclear whether anxiety is a cause or a symptom of reduced achievement. Carver, et al (1983) found that self directed attention was a desirable cognitive strategy for students low in test anxiety, but was detrimental to the performance of anxious students. Other researchers failed to find any connection between anxiety and cognitive performance (Fulkerson, et al, 1984, Liabre and Suarez, 1985, Siegal, et al, 1985).

In the current study, successful and unsuccessful intermediate algebra students at a central Texas community college were characterized by their responses to questions concerning their backgrounds, work loads, and attitudes. It was hoped that this approach would provide knowledge that could be used by instructors and counselors to help improve student performance in this high school level algebra course.

METHODOLOGY

The target study population consisted of all students in 8 sections of an intermediate algebra course at a central Texas community college during the summer of 1990. Each of the 8 sections had a different instructor, but used the same text and followed the same syllabus. Each student who agreed to participate was asked to complete a short questionnaire on the first day of class and a related questionnaire at the end of the term. Of 157 students on the official rosters, a total of 124 completed one or both questionnaires. The first questionnaire was completed by 105 students, and the second by 77 students.

On the first questionnaire the students were asked to provide information on class and work hours, sex, ethnicity, prerequisite course work, enrollment in the optional lab course, and college major. On both the first and second surveys, the students were asked to respond to 10 questions concerning attitudes toward mathematics using a 5 part scale ranging from "strong no" to "strong yes", with each response assigned a numerical value of 1 to 5 (see Appendix).

To assess the significance of the study variables relative to achievement, students were classified as successful or unsuccessful based on their final grades.

Students who received final grades of A, B, or C were classified as successful, while students who received grades of D, F, or W (withdrawn) were classified as unsuccessful.

Although each class was graded by a different instructor, course content and criterial tasks were approximately the same. Consequently, similar grades are believed to reflect similar achievement levels among all the respondents. Classification of withdrawn students as unsuccessful is justified by drop slip records which indicate that most students who withdraw are experiencing difficulty with the course material.

For each questionnaire item, the means and standard deviations of the numerical values of the responses were computed for the entire sample, and for subsamples comprised of successful and unsuccessful students. The t statistic was used to test the null hypothesis, that the mean responses for successful and unsuccessful students were identical. If the null hypothesis could be rejected at the .05 level, the differences between means were believed to be statistically significant.

In addition to the analyses to determine which of the study variables were characteristic of successful or unsuccessful students, the responses to specific questions were compared. To investigate whether students believed that their grades did not accurately measure their achievement, the responses to questions 9 and 10 of the second questionnaire were compared for both successful and unsuccessful students. To determine whether students were aware of their level of achievement, their expected grades in the course (survey 2, question 9) were compared with their actual grades.

Three comparisons were made to investigate how student attitudes might have changed during the term. These comparisons were made between similar questions

asked on both questionnaires. The comparisons were made within, rather than between, groups comprised of successful students who completed both questionnaires and unsuccessful students who completed both questionnaires. Mean scores were compared to determine the direction of change, and the t test was used to evaluate the null hypothesis, that is, that the mean responses were identical on both questionnaires. Again, if the null hypothesis could be rejected at the .05 level, the differences between survey responses were believed to be statistically significant. The following comparisons were made:

1. Mathematics enjoyment. Numerical values of responses to question 10 on survey 1 and question 1 on survey 2 were compared.

2. Amount of outside help needed to understand course material. The numerical values of the responses to question 2 on survey 1, and question 8 on survey 2, were compared.

3. Attribution of failure, or difficulty with mathematics, to course structure or quality of instruction. The numerical values of the responses to question 6 on survey 1 and question 4 on survey 2 were compared.

Finally, from a sample comprised of all students who completed both questionnaires, responses to two pairs of questions, each pair comprised of one question from each survey, were correlated. Fisher's Z transformation was used to test the hypothesis that the correlation coefficients for both the successful and unsuccessful

groups were the same. If the hypothesis could be rejected at the .05 level, the difference in the correlation coefficients was believed to be significant. The following correlations were calculated:

1. The extent to which a belief in the efficacy of effort predicts effort. Question 7 on survey 1 and question 6 on survey 2 were correlated.

2. The extent to which a student believes that he or she has high ability and does not need to work hard predicts less effort. Responses to question 3 on survey 1 were inverted by subtracting the numerical value of the actual responses from 6. Then the inverted responses for question 3 on survey 1 were correlated with the responses to question 6 on survey 2.

RESULTS

The sample was 50% male. Respondents were 76% Anglo, 0% Black, 21% Hispanic, and 3% other races. Two Blacks actually completed survey 1, but dropped the class before the official roster was determined, so they were not part of the sample. Respondents reported taking an average of 5.3 semester hours of classes, including intermediate algebra, in addition to working an average of 25.9 hours per week. The students reported completing elementary algebra, which is typically taken in 8th or 9th grade, 6.9 years prior to the survey date, earning an average grade of 2.9 (A=4.0). The optional homework laboratory course was taken by 13% of the respondents.

Students receiving final grades of A, B, or C accounted for 56% of the sample, yielding a drop out or failure rate of 44%. This understates the true failure rate, because students who dropped the course during the first 12 class days were not on the final rosters, and were not included in the study. Among the successful students, 45% were male, 78% were Anglo, 18% were Hispanic, and 4% were other races. Among the unsuccessful students, 57% were male, 75% were Anglo, 23% were Hispanic and 2% were other races.

Unsuccessful students enrolled for significantly more class hours (mean=6.1) than successful students (mean=4.7; t=-2.64, DF=101). Interestingly, the number of hours spent on part time jobs was not significant. It was also found, that unsuccessful students anticipated needing more outside help than successful students (t=-2.69, DF=102), and were more likely than successful students to believe that tests had not measured their true achievement in previous mathematics courses (t=-2.25, DF=103). Not surprisingly, successful students were more confident than unsuccessful students that they had learned the course material well (t=2.55, DF=74) and that they were ready for a more advanced course after completing intermediate algebra (t=3.82, DF=75). Successful students were more likely after taking intermediate algebra, than before, to report that they enjoyed mathematics (t=-1.84, DF=94), and they were less likely to attribute difficulty understanding mathematics to course structure or quality of instruction (t=2.24, DF=93).

Interesting differences were noted between successful and unsuccessful students in their awareness of their grades and their belief that their grades in intermediate algebra would accurately measure their achievement. Among successful students, 92% correctly

anticipated their grades, while only 56% of the unsuccessful students knew approximately what grade they would receive, with 44% expecting higher grades than they actually earned. Ninety-one percent of the unsuccessful students who completed the second questionnaire believed that their achievement was higher than their grades would indicate.

Among successful students, a slight positive correlation (r=.06) was observed between a belief in the efficacy of effort and actual effort, while unsuccessful students showed a negative correlation (r=-.15). Among unsuccessful students, a strong correlation (r=.26) was observed between not working hard, and believing that hard work was not necessary because of high ability, while successful students showed a low correlation between these items (r=.02). These results suggest that unsuccessful students may be more likely than successful students to attribute success to innate ability rather than to effort. Therefore, unsuccessful students may have a greater tendency than successful students to adopt a performance goal, making them vulnerable to learned helplessness if they encounter difficulty achieving course objectives. However, using data from the present study, the null hypothesis cannot be rejected at the .05 level for the first correlation (z=.51) or for the second correlation (z=-.62). The lack of statistical significance which can be attributed to the differences in the correlation coefficients observed for the successful and unsuccessful groups, is related partly to the small size of the unsuccessful student sample for these items (n=10).

DISCUSSION AND CONCLUSIONS

Many characteristics of learners which have been found in previous investigations to be related to mathematics achievement, also appear, based on this study, to apply to intermediate algebra students at a community college. Successful students were more confident, less dependent on outside help, and less likely to attribute failure to external factors such as course structure or criterial tasks than unsuccessful students. In general, women were found to be at least as successful as men, as is typical for mathematics courses at this level, and Hispanic students were found to achieve at a rate below that of the general student population. The study indicated that taking intermediate algebra was a positive experience, with typical students reporting enhanced mathematics enjoyment and a decline in their tendency to attribute failure to external factors.

Regarding achievement related motivation, the students who participated in this study approached intermediate algebra with optimism about their prospects for success, and the belief that they could be successful if they worked hard. These attitudes typify a learning goal orientation, which is believed to be beneficial, particularly for lower ability students. However, this study failed to demonstrate a clear association between a learning goal and success in intermediate algebra. Also, there was no clear relationship between adopting a learning goal and actually working hard.

A significant finding from the study was that unsuccessful students tended to take more courses along with intermediate algebra than successful students. While it is not clear whether this result is unique to

the summer sessions, during which the pace of the subject course is much faster than during the regular semester sessions, no similar distinction between successful and unsuccessful students was observed for the number of hours spent in part time employment. Possibly, jobs draw on different personal resources than classes do.

Another interesting result of the study was that many unsuccessful students who completed the second survey seemed to be unaware that they were not meeting the course objectives, and commonly expected higher grades than they actually received. These students also tended to believe that test results underestimated their actual achievement. The students who dropped the course, and, therefore, did not complete the second survey, were probably more aware of their lack of progress than the students who were failing, but finished the course. However, the students who failed, but did not drop, were about 42% of the unsuccessful students, so this lack of awareness of achievement level may be an important characteristic of many unsuccessful students. It is not clear whether this lack of awareness is the legacy of liberal high school grading systems, a result of inadequate feedback by instructors, or an intrinsic characteristic of many low achieving students. The ability of students to monitor their own progress, and the effect of this self monitoring on achievement, may be an interesting topic for future research.

APPENDIX

FIRST SURVEY:

(1) I do well in most subjects, but I often have trouble with mathematics.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(2) I usually need someone to help me outside of class in order to understand the material in a mathematics course.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(3) I generally have good mathematics ability, so I don't have to work too hard to get good grades.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(4) I expect to do well in this course.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(5) I intend to take a more advanced mathematics course after completing Intermediate Algebra.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(6) When I don't do well in mathematics, it is usually because the course is poorly structured or the instructor does not effectively convey the material.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(7) I can usually do well in mathematics if I work hard.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(8) I am usually able to understand the material in a math course, but I often don't do well on tests.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(9) I have the background necessary to understand the material which is supposed to be covered in this course.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(10) I generally enjoy mathematics.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

SECOND SURVEY:

(1) I enjoyed this course.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(2) This course was pretty easy.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(3) I think that I have a good understanding of the material covered in this course.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(4) When I had trouble in this course, it was usually because of the way the course was structured or the material was presented.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(5) I could have done better in this course if I had worked harder.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(6) I worked very hard in this course.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(7) I think that I am ready to take a more advanced math course.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(8) I needed a lot of help outside of class in order to understand the course material.
1=Strong no 2=Weak no 3=Uncertain 4=Weak yes 5=Strong yes

(9) I expect to receive the following grade in this course.
1=A 2=A or B 3=B 4=B or C 5=C 6=C or D 7=D or F

(10) If I were to grade myself based on how well I know the material rather than on how well I did on tests, I would receive the following grade.
1=A 2=A or B 3=B 4=B or C 5=C 6=C or D 7=D or F

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